



The Living With a Star Space Environment Testbed Experiments

Mike Xapsos

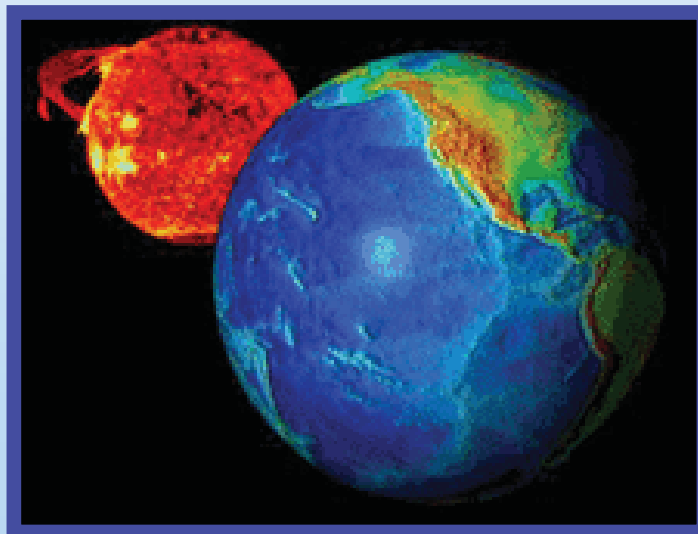
NASA Goddard Space Flight Center

May 21, 2014

Outline



- ***Living With a Star (LWS) Space Environment Testbed (SET)***
 - *Objective & Scope*
 - *Investigations*
- ***SET Payload on the Air Force Research Laboratory (AFRL) Demonstration & Science Experiments (DSX) Spacecraft***
 - *Space Weather Monitor*
 - *Carrier Containing 4 Board Experiments*



Living With a Star Space Environment Testbed



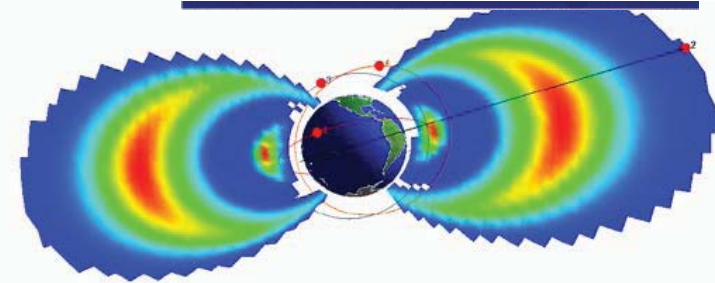
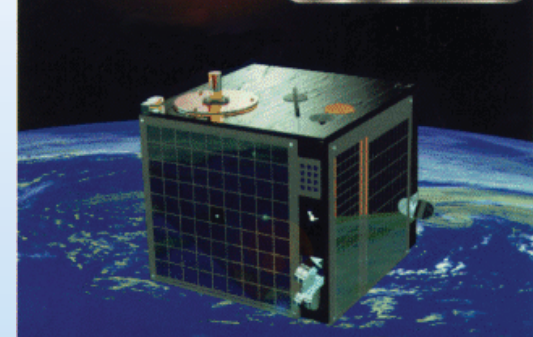
Objective

Improve the engineering approach to mitigate the effects of space weather on spacecraft design & operations

Scope

Spacecraft hardware & design / operations tools whose performance is affected by space weather, including:

- *Radiation Environment Within Spacecraft,*
- *Microelectronics,*
- *Materials,*
- *Plasma & Charging Effects, and*
- *Detectors & Sensors.*





Space Environment Testbed Investigations

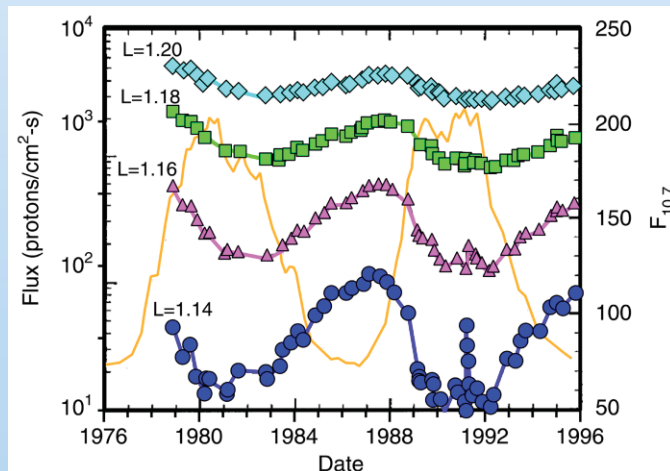
Investigators funded through NASA
Research Announcements (NRAs)

SET NRA #1 – Space Data Mining:

- 9 awards in FY01 totaling \$800 K
- Products available on SET web site

SET NRA #2 - Space Experiments:

- 7 awards in FY03 totaling \$1.5 M
- Selected experiments to be flown on AFRL's DSX Mission



To be presented by M. A. Xapsos at the Single Event Effects (SEE) Symposium and the Military and Aerospace Programmable Logic Devices (MAPLD) Workshop, La Jolla, CA, May 19-22, 2014.

AFRL Demonstration and Science Experiments Mission



Objective

Space flight experiments designed to significantly enhance capability to operate in the harsh radiation environment of Medium Earth Orbit (MEO). View toward communication, surveillance and navigation capabilities.

Launch and Orbital Information

DSX is baselined for a 6000 x 12,000 km, 45° inclination orbit with 1 year of operations. Launch on SpaceX Falcon Heavy rocket in mid-2015 (2016?).

Three Types of Experiments

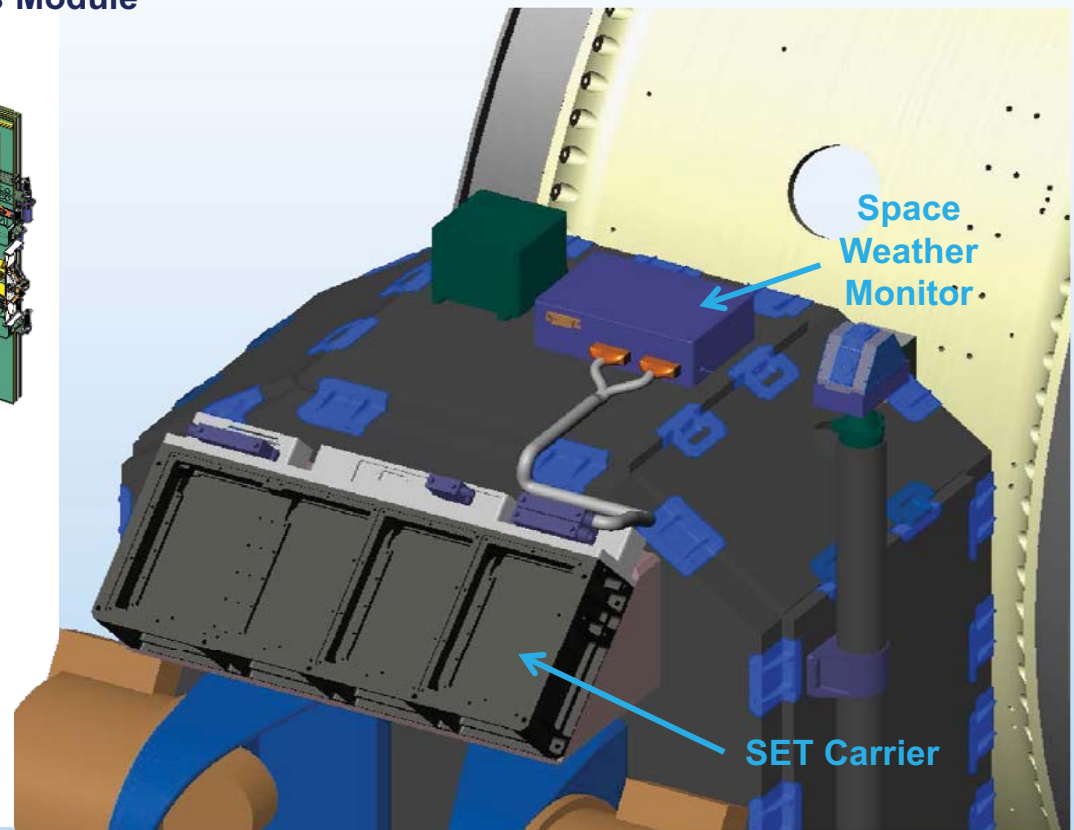
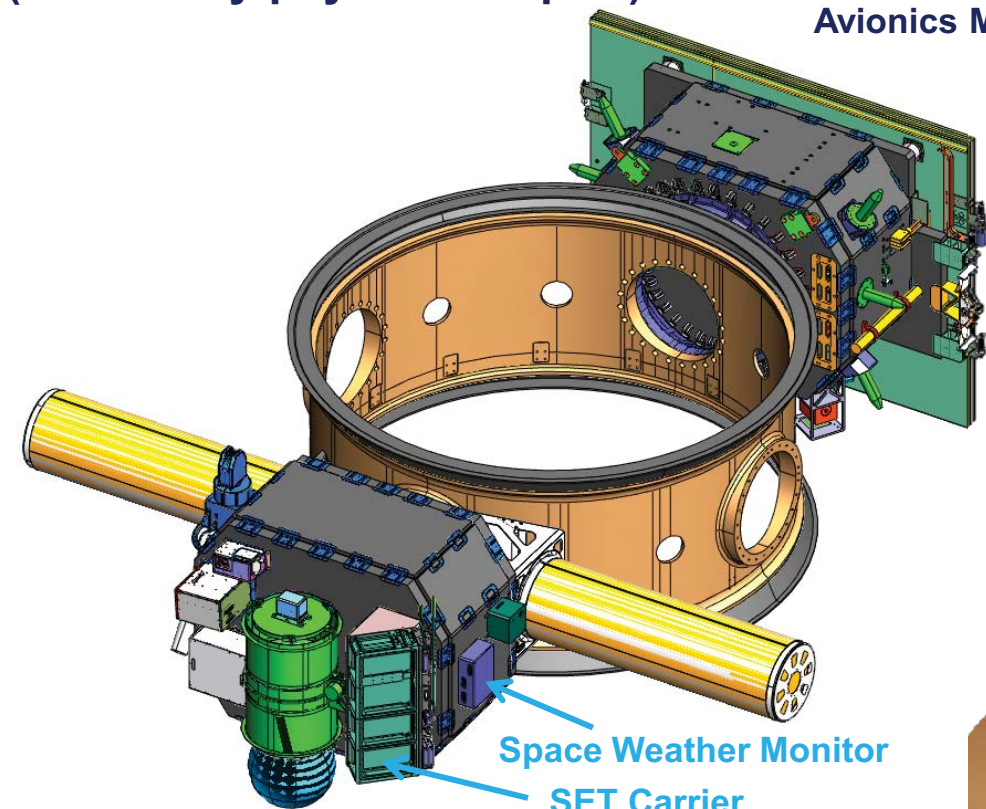
- 1. Wave Particle Interaction Experiment: Transmit Very Low Frequency (VLF) waves and understand effects on magnetospheric electrons.***
- 2. Space Weather: Collect data and develop models for the highly variable Medium Earth Orbit (MEO) Slot Region.***
- 3. Space Environment Effects: Rad effects on electronics, thermal materials and optical coatings.***

SET on DSX

SET is one of nine payloads on DSX

DSX structure
(secondary payload adapter)

Avionics Module



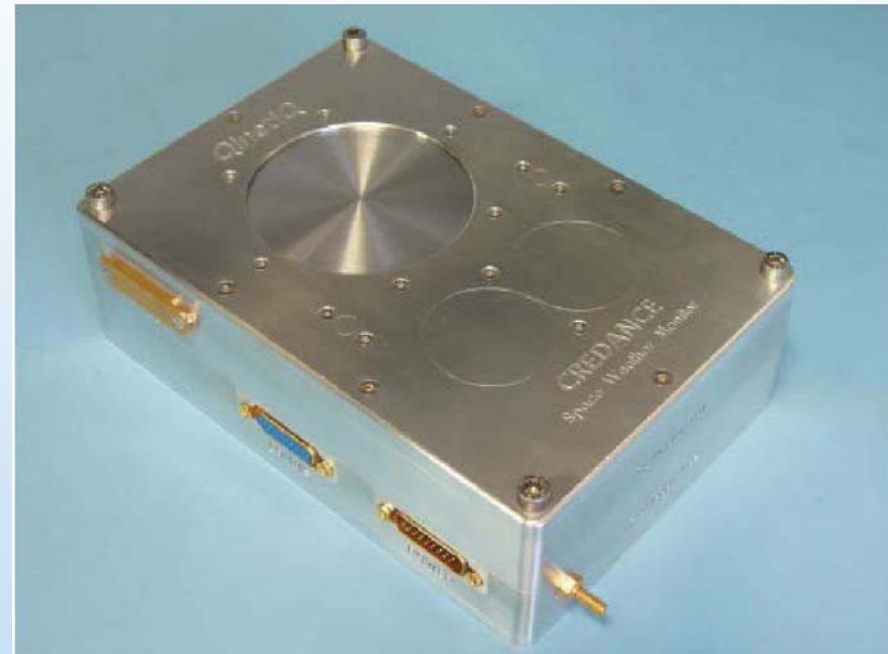
Payload Module

SET Payload:

Cosmic Radiation Environment Dosimetry and Charging Experiment (CREDANCE)



- **Principal Investigator:**
 - Clive Dyer, QinetiQ
- **Objectives:**
 - Demonstrate the value of a compact space weather monitor for spacecraft
 - 1 kg mass; 2.5 W power
 - Provide data to other experiments
 - Use data for trapped particle model development
- **Measurements:**
 - > 40 MeV proton flux
 - Electron charging current at 3 shielding depths
 - Ionizing dose at 2 shielding depths
 - Linear Energy Transfer (LET) spectra of heavy ions ranging from 0.1 to 25 MeV-cm²/mg

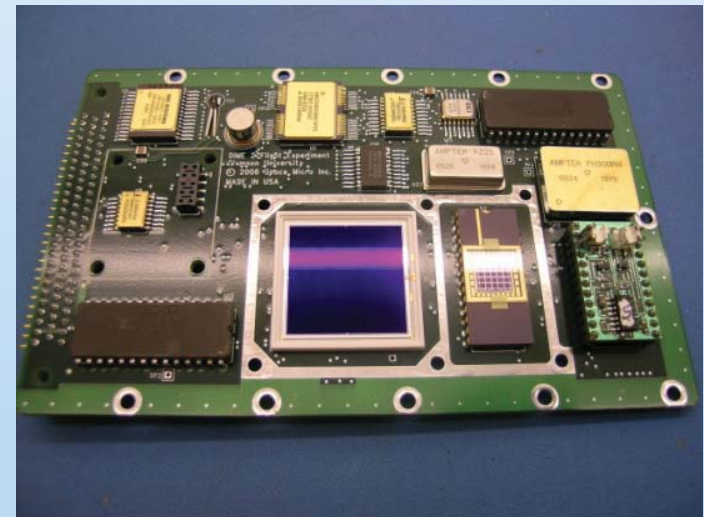
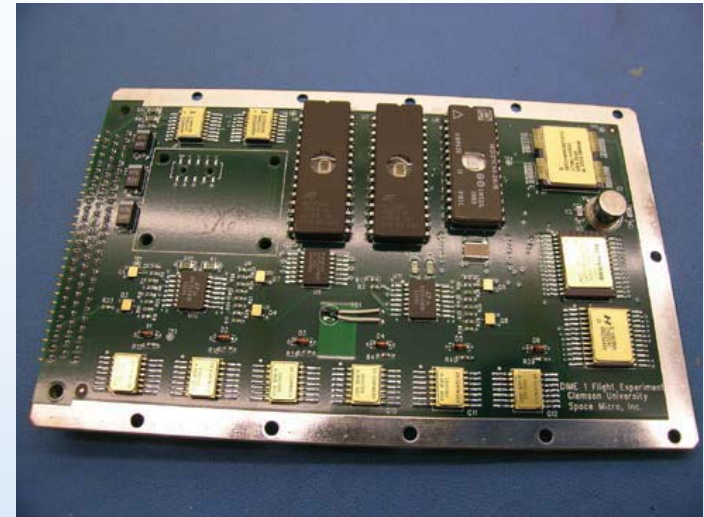


Credit: QinetiQ, United Kingdom; <http://lws-set.gsfc.nasa.gov>

SET Payload: Dosimetry Intercomparison and Miniaturization Experiment (DIME)



- **Principal Investigator:**
 - *Peter McNulty, Clemson*
- **Objectives:**
 - *Provide novel dosimetry data with Commercial Off the Shelf (COTS) microelectronic structures*
 - *“Back-up” environment data for other experiments*
- **Measurements**
 - *Total dose from Radiation-Sensing Field-Effect Transistors (RADFETs), Erasable Programmable Read Only Memories (EPROMs) and Optically Stimulated Luminescence (OSL) films*
 - *Non-ionizing dose from Light Emitting Diode (LED) characteristics in OSL circuitry*
 - *LET spectra from p-type silicon/n-type silicon junction arrays*



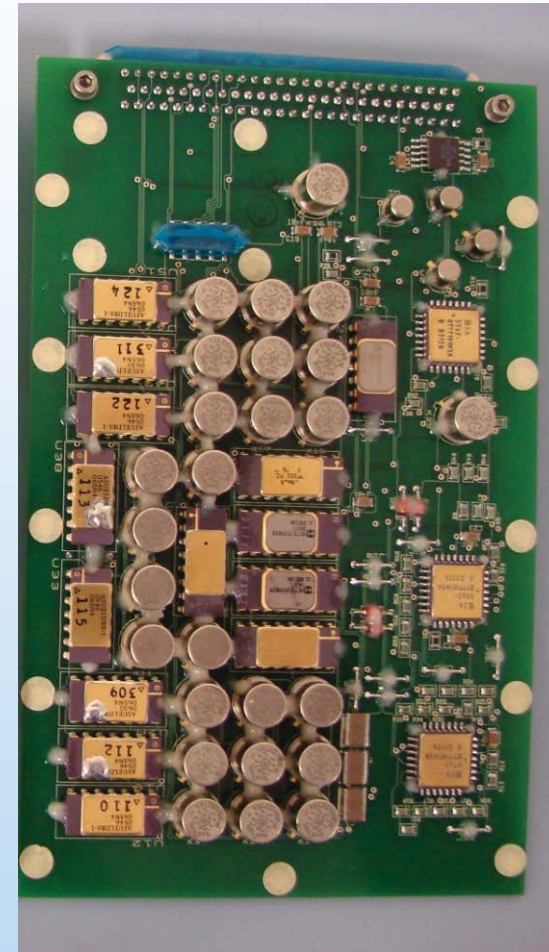
Credit: Clemson University; <http://lws-set.gsfc.nasa.gov>

SET Payload:

Enhanced Low Dose Rate Sensitivity (ELDRS)



- **Principal Investigator:**
 - *Hugh Barnaby, Arizona State University*
- **Objective:**
 - *Improve understanding of the physics of the Enhanced Low Dose Rate Sensitivity (ELDRS) effect in order to improve/validate ground test protocol for linear bipolar technologies and reduce design margins*
- **Space Measurements:**
 - *Transistor characteristics of 24 bipolar junction transistors with well-controlled, different processing characteristics:*
 - *Oxide thickness*
 - *Passivation layer*
 - *Hydrogen content*

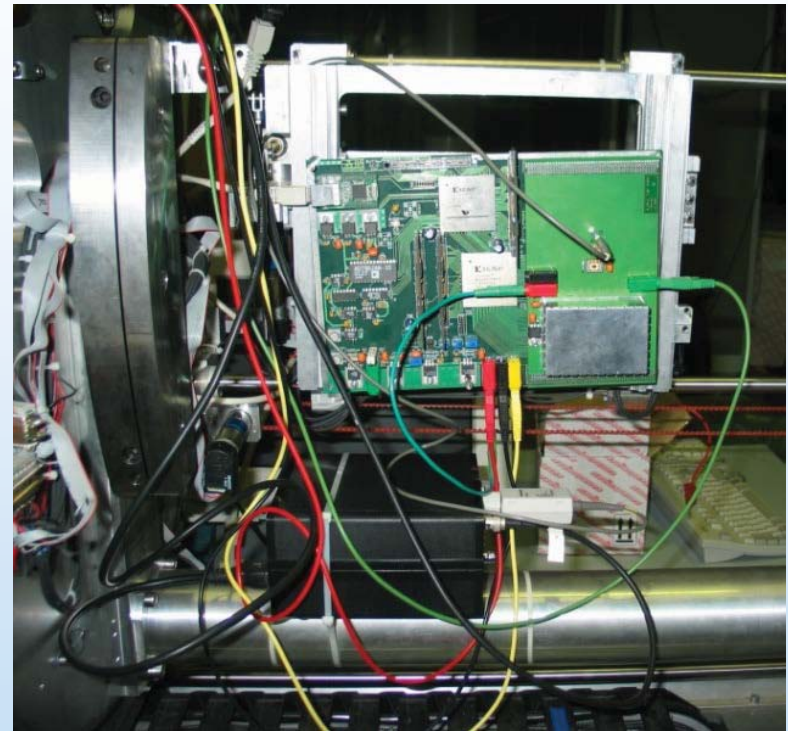


Credit: Arizona State University; <http://lws-set.gsfc.nasa.gov>

SET Payload: Commercial Off the Shelf-2 (COTS-2)



- **Principal Investigator:**
 - *Raoul Velazco, Techniques de l'Informatique et de la Microelectronique pour l'Architecture des systemes integres (TIMA), France*
- **Objective:**
 - *Validate approach to single event analysis in complex circuits with large phase space by combining measurements of static cross sections and fault injection techniques*
- **Space Measurements:**
 - *Single events in COTS Field Programmable Gate Arrays (FPGAs)*

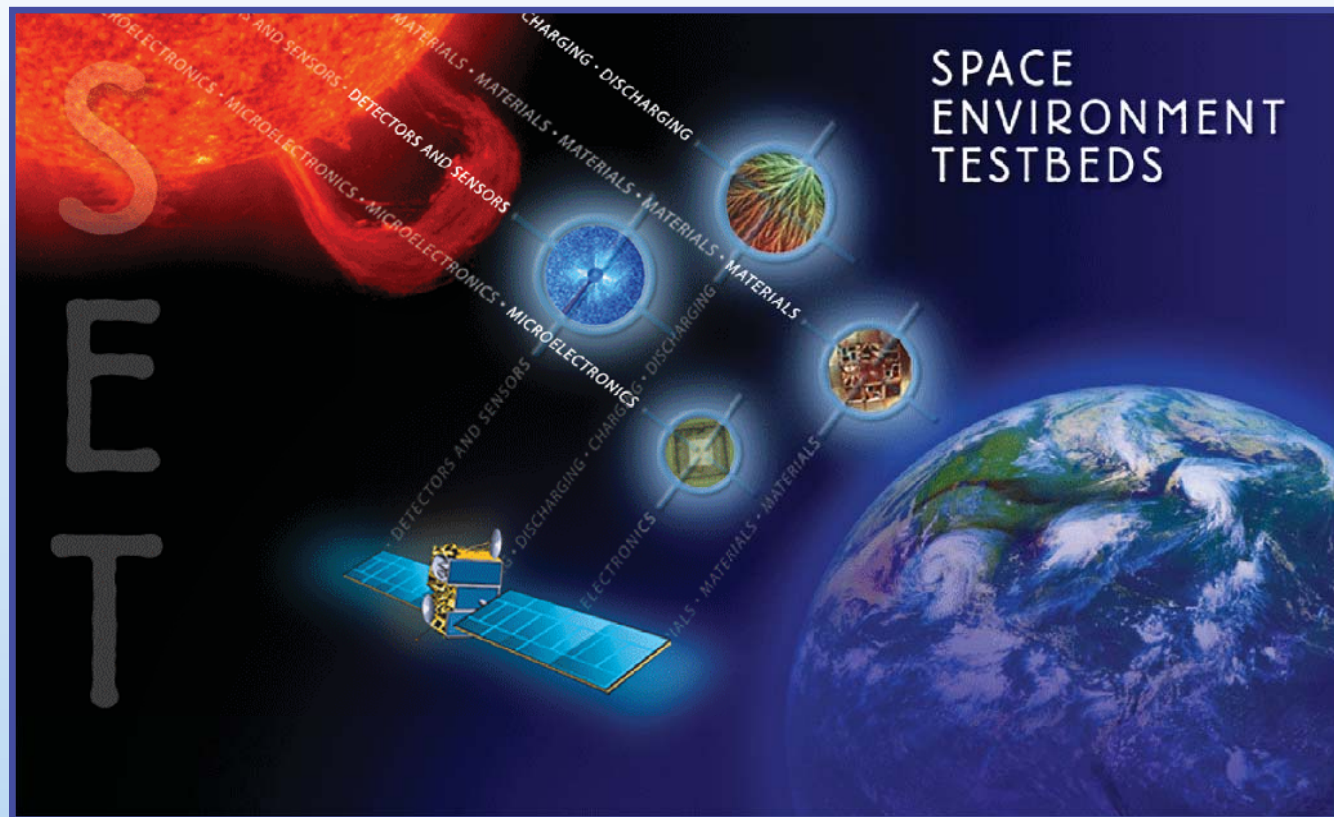


Credit: TIMA, France; <http://lws-set.gsfc.nasa.gov>



All space data will be publicly available on the SET website:

<http://lws-set.gsfc.nasa.gov>





Acknowledgments

- ***Dana Brewer***
 - *LWS Program Executive*
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 - ***Ken LaBel***
 - *Project Technologist*
 - ***Chuck Naegeli & Reggie Eason***
 - *Project Managers*
 - ***Chikia Barnes***
 - *Project Administrator/Education & Public Outreach Lead*
- ... and many others on the SET team***